INDOOR AIR QUALITY ASSESSMENT

Horace Mann School
Oak Street
Franklin, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
June 2003

Background/Introduction

At the request of David Roche, Building Commissioner, Town of Franklin, the Bureau of Environmental Health Assessment (BEHA) of the Massachusetts Department of Public Health (MDPH) was asked to provide assistance and consultation regarding water penetration in several areas of the Horace Mann School (HMS). At the time of the assessment, the building was under construction/renovation. This request for an indoor environmental assessment was prompted by reports of water damage to interior walls constructed from gypsum wallboard (GW).

On April 9, 2003, a visit was made to this school by Michael Feeney, Director of the Emergency Response/Indoor Air Quality (ER/IAQ) program, BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied by Cory Holmes, an Environmental Analyst in the ER/IAQ program, as well as Earnest Alix, Clerk of the Works and Mr. Roche.

The HMS construction/renovation project consists of renovations to the existing Horace Mann School and the construction of a two-story addition. At the time of the assessment, the *roof was not installed,* and interior walls and ceilings of the new addition were not complete.

The building had previously been evaluated by an environmental consultant, Covino, Inc. (Covino), for biological and moisture contamination in February of 2003. Covino found significant fungal growth in a number of areas in the school and made the following recommendations:

1. Remove all fungal growth and associated surface contamination;
2. Use and maintain the building in a manner that does not promote mold growth;
3. Disinfect studs and U-channels of walls;
4. Install new insulation batting and GW; and
5. Remediate water infiltration. (Covino, 2003)

Methods

Visual observation of GW for mold was conducted. Water content of GW was measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. Air tests for temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Test results are shown in Tables 1-2.

Results/Discussion

The school complex can be divided into two sections: the "finished" wing, located closest to the street, and the unfinished section of the building. The majority of problems observed in the building complex were in the unfinished sections of the building. Moisture samples were taken in both sections of the complex for comparison.

The building was evaluated on a day of moderate to heavy rainfall, with an outdoor temperature of 44^{o}F and relative humidity of 87 percent. Relative humidity indoors was measured in a range of 42 to 89 percent in various areas of the school complex. The following conditions were noted concerning water penetration into the interior of the building:

- Active leaks were observed in a number of areas on the top floor of the new addition. Water was noted pouring into the interior of the building through ducts installed in the roof decking (see Picture 1).
- During the assessment, accumulated moisture was noted on ceilings, walls and the cement floor (see Pictures 2-4).
- Blown-on ceiling insulation on floor/roof decking was found to be wet (see Picture 5).
- Water damage was noted on the floor/ceiling of a wing undergoing renovation. A cardboard-like material with a mesh underlay was used as forms for the poured concrete

slabs that make up the floor (see Pictures 6 and 7). Water was seen dripping through this mesh, presumably from the moistened cardboard material underlying the concrete slab.

- In an area formed by a handicapped access ramp for the auditorium area, an accumulation of 3-6 inches of rainwater was noted. This water was leaking into the auditorium through the common wall (see Pictures 8 & 9). Moistened wall plaster and accumulated debris were also noted beneath the stage.
- Some ductwork interiors are lined with fiberglass insulation. Both installed and stored ductwork were found to have moistened insulation.
- Insulation of the boilers was found to be moistened.
- The edges of the gymnasium hardwood floor near locker room doorways were found to be moistened (see Picture 10).

GW is used in a number of applications. The material was used extensively in building areas that later experienced heavy water accumulation/penetration. Moisture measurements were taken in GW (see Picture 11) and wall plaster in areas with obvious water damage, as well as in areas that appeared not to be water damaged. In many areas under renovation, GW had measurable moisture levels, ranging from 0.1 percent in the dry, "finished" wing to 99% saturation in the "unfinished" wing. The exterior curtain walls of the unfinished sections are brick (see Picture 12). Behind the brick curtain wall is a Styrofoam-like material that is adhered to GW (see Picture 13). Moisture samples were taken in numerous areas where the Styrofoam-like material is adhered (see Picture 14). In numerous areas, this GW had moisture readings indicating excessive moisture exposure. Similar moisture concentrations were found in GW making up interior dividing walls. Bare GW and painted cinderblock walls within many areas had what appeared to be visible mold growth (see Pictures 15-18). This mold growth indicates

that GW was saturated with water, resulting in the colonization of mold. In addition, a stack of GW to be installed had elevated moisture content (see Picture 19).

Remediation of mold contaminated GW with an antimicrobial agent is not recommended. BEHA personnel had consulted with Dr. Harriet Burge, Associate Professor of Environmental Microbiology in the Department of Environmental Health at the Harvard School of Public Health, about concerns of mold contamination in GW on previous investigations. According to Dr. Burge, the reoccurrence of mold growth after the application of bleach is common. Bleach consists of sodium hypochlorite in a 5 percent concentration mixed with water. Mold colonization of GW can penetrate through its entire structure. When applied to moldy GW, the water of the bleach solution penetrates into the moldy GW, but the sodium hypochlorite remains on the surface of the GW. The sodium hypochlorite disinfects the surface mold that it comes in contact with on the GW surface, but not the mold beneath the surface. The additional water added to the subsurface mold fuels a spurt in growth, which increases mold colonization of the GW. As a result, mold colonies appear on the surface of treated GW shortly after application of bleach. (Burge, 1999)

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Mold colonized GW cannot be adequately cleaned to remove mold growth.

As discussed, the roof had not been replaced, and several areas of the exterior wall system were unfinished at the time of the BEHA assessment. These open breaches of the building envelope can be a source of water infiltration into the building during driving rain.

Installing a new roof and sealing the exterior wall system will serve to prevent further damage to interior walls.

Ductwork was partially installed in the building. Openings to ductwork were noted in classrooms through interior walls above hallway doors. Some of the duct openings were not sealed to prevent contamination by renovation-generated dust. Ductwork to be installed was found stored on the floors of the gymnasium and outdoors (see Pictures 20-22). These ducts were heavily coated with dust. It is good practice to isolate newly installed ductwork to avoid dust contamination of these materials (SMACNA, 2000). Since it appears that these ducts were open in a number of areas throughout the building, there are opportunities for both installed and/or stored ductwork to be contaminated by renovation pollutants. Therefore, the design of the ductwork system must be assessed to determine how it may be impacted by renovation activities.

Conclusions/Recommendations

In view of the findings at the time of the inspection, the following recommendations are made:

1. Implement previous recommendations made by Covino.
2. Establish the integrity of the building envelop by:
   2.1. installing the new roof and
   2.2. sealing the exterior wall system to prevent further damage to interior walls.
3. Remediate mold contaminated building materials in a manner consistent with *Mold Remediation in Schools and Commercial Buildings* published by the US Environmental Protection Agency (US EPA) (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html.

4. Replace all GW that show visible microbial growth.
5. Consult a building engineer to determine whether the following building components are salvageable with regard to water/damage, mold growth and/or structural integrity:
   5.1. GW adhered to the Styrofoam-like material;
   5.2. insulated ductwork;
   5.3. gymnasium floor;
   5.4. wall plaster in the auditorium;
   5.5. spray-on insulation on roof/floor decking; and
   5.6. the boilers.
6. Clean dust off all ductwork that remains to be installed and store it in a manner that prevents contamination with renovation-generated dust.
7. Clean the interior of all ventilation system ductwork that has already been installed. Seal each end to prevent contamination.
8. Seal construction barriers with polyethylene plastic and duct tape to create a secondary barrier to prevent migration of renovation generated pollutants into finished areas.
9. Implement prudent dust control procedures to minimize dust generation inside the building. This may include constructing barriers, sealing off areas and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended.
10. In order to maintain a good indoor air quality environment on the building, consideration should be give to adopting the US EPA document, "Tools for Schools", which can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.

11. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

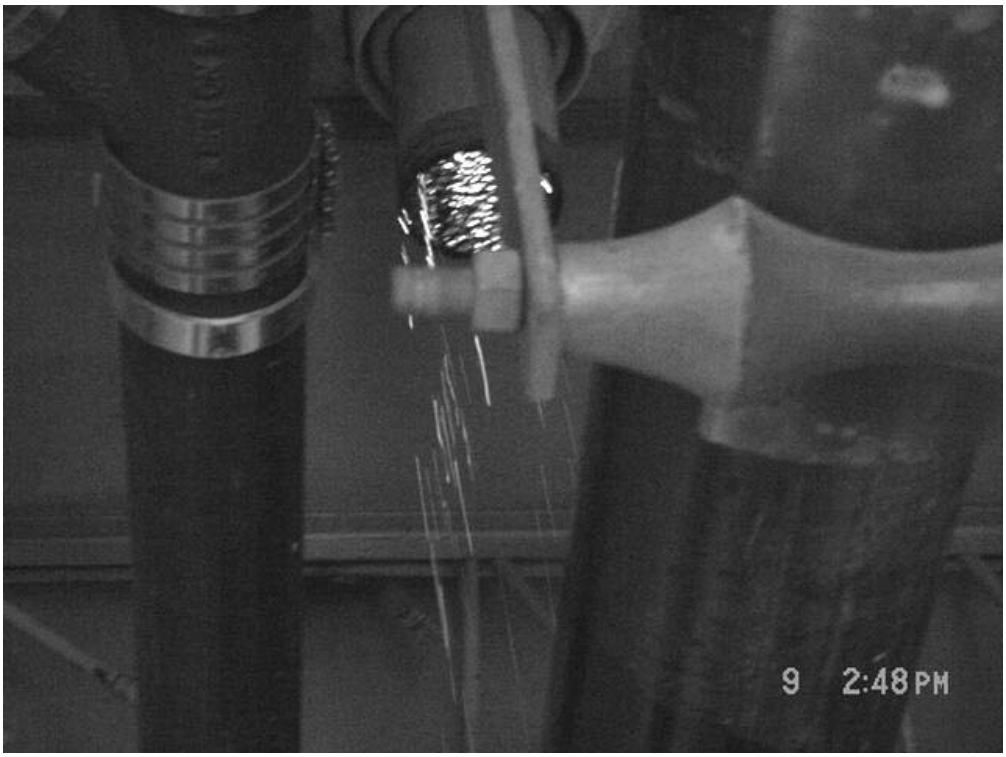
Burge. 1999. Personal Conversation with Dr. Harriet Burge, Harvard School of Public Health. December 13th, 1999.

Covino. 2003. Covino Project 03.00201 Initial Microbial Assessment, Horace Mann School, Franklin, MA. Dated March 4, 2003.

SMACNA. 2000. Duct Cleanliness For New Construction Guidelines. Sheet Metal And Air Conditioning Contractors' National Association, Inc., Chantilly, VA 20151-1209 http://www.smacna.org/products/publications/download.cfm?download_file=duct%5Fcleaning%5Ftech%5Fpaper%5F4%2D01%2Epdf

US EPA. 2001. *Mold Remediation in Schools and Commercial Buildings*. Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. March 2001.

Picture 1

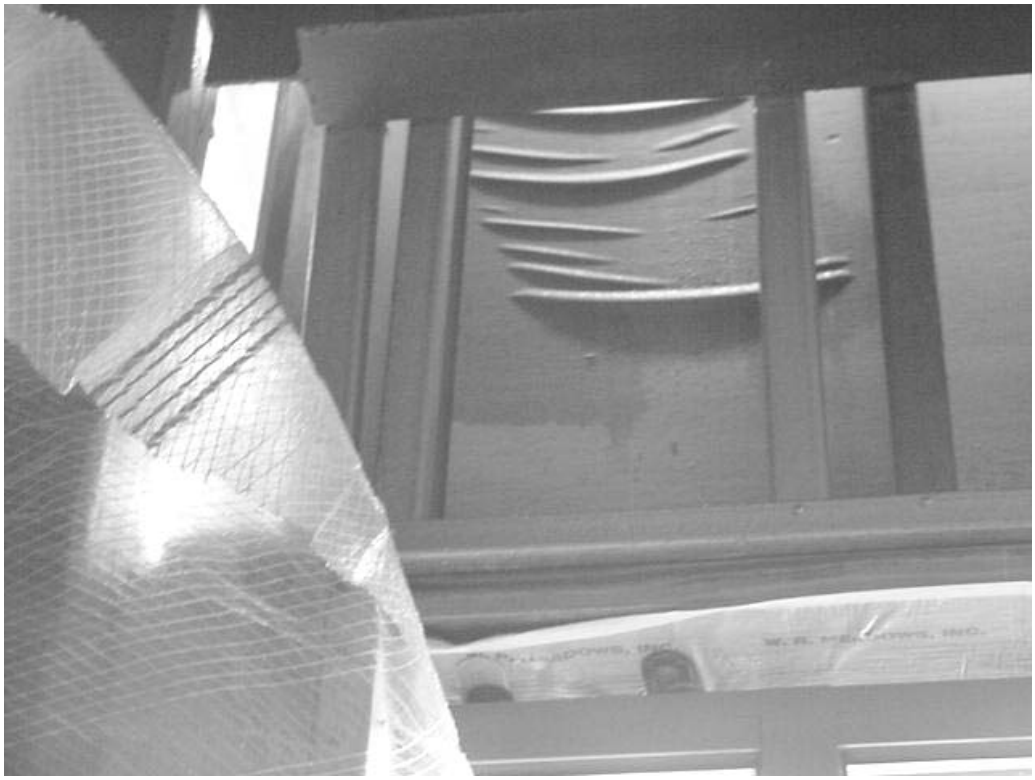


Water Pouring into the Interior of the Building through Ducts Installed in the Roof Decking

Picture 2

2-4 Inches of Standing Water on Floor Due To Roof Leaks

Picture 3



Sagging Paper Backing Of GW Saturated with Moisture

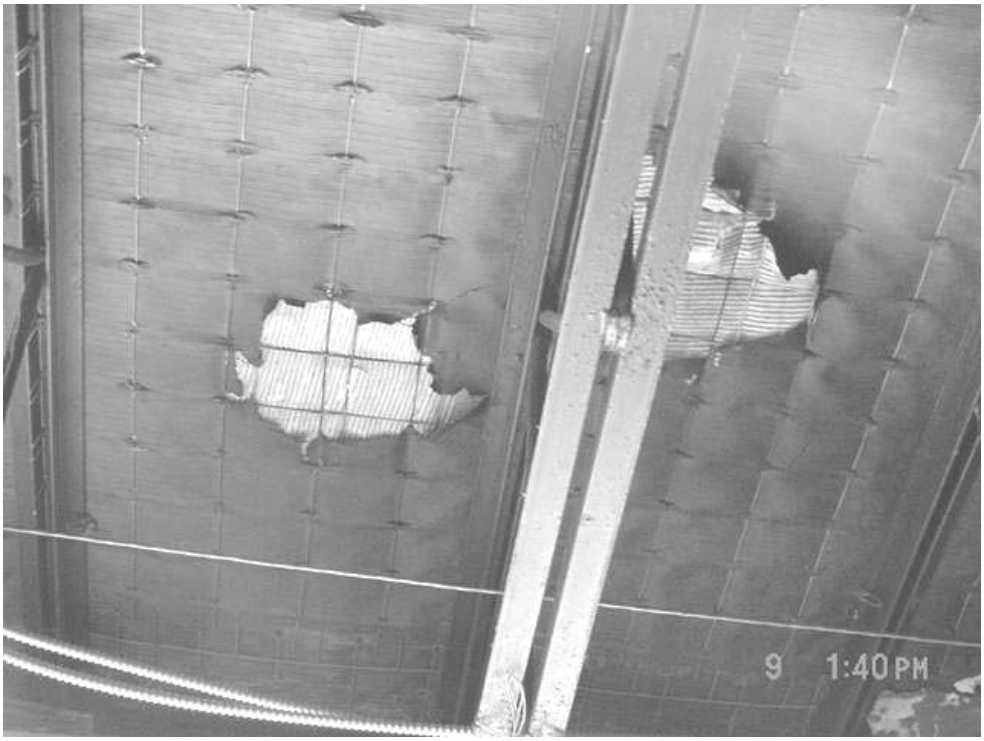
Picture 4

Standing Water on Cement Floor

Picture 5

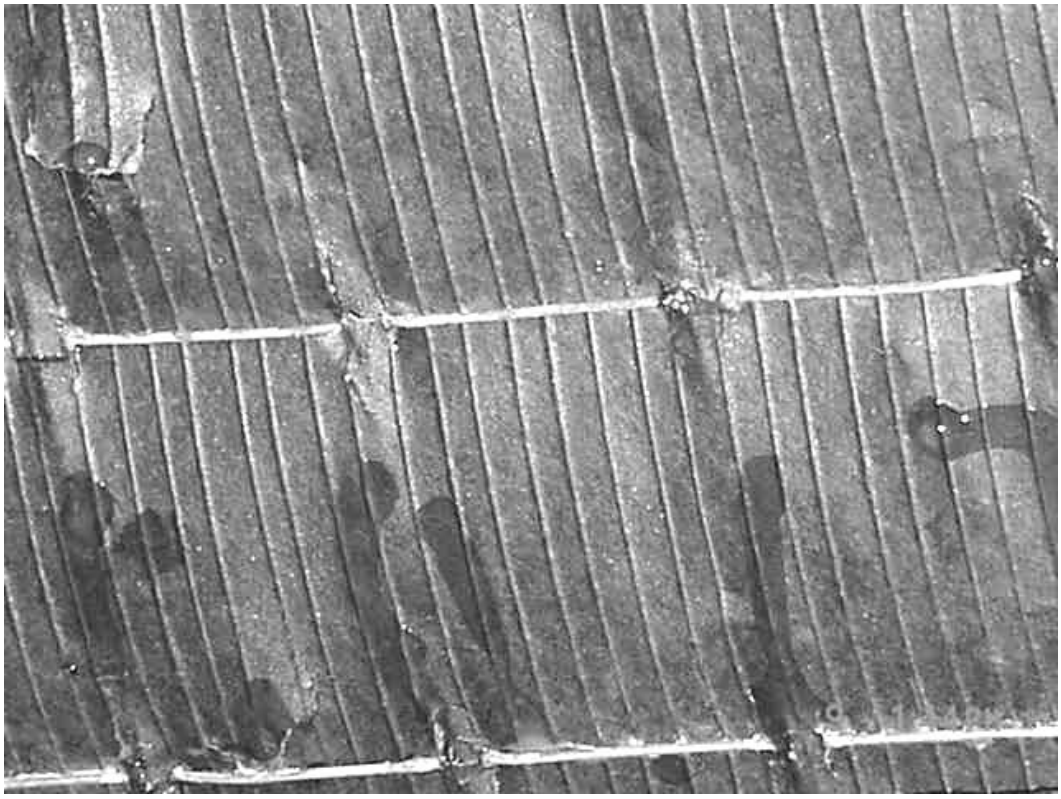
Blown-On Ceiling Insulation Was Found To Be Wet

Picture 6



Floors Appeared to Have Been Formed Using a Cardboard-like Material Held By Cloth Mesh

Picture 7



Water Accumulation on Cardboard Ceiling Backing Material

Picture 8

Handicapped Ramp Area Holding 3-6 Inches of Water, Note This Water Was Leaking Through The Wall into the Auditorium

Picture 9

Water Seepage (Dark Staining) Beneath the Stage in the Auditorium, Opposite The Handicapped Ramp in Picture 8

Picture 10

Gymnasium Hardwood Floor at Doorway Was Found To Be Heavily Moistened

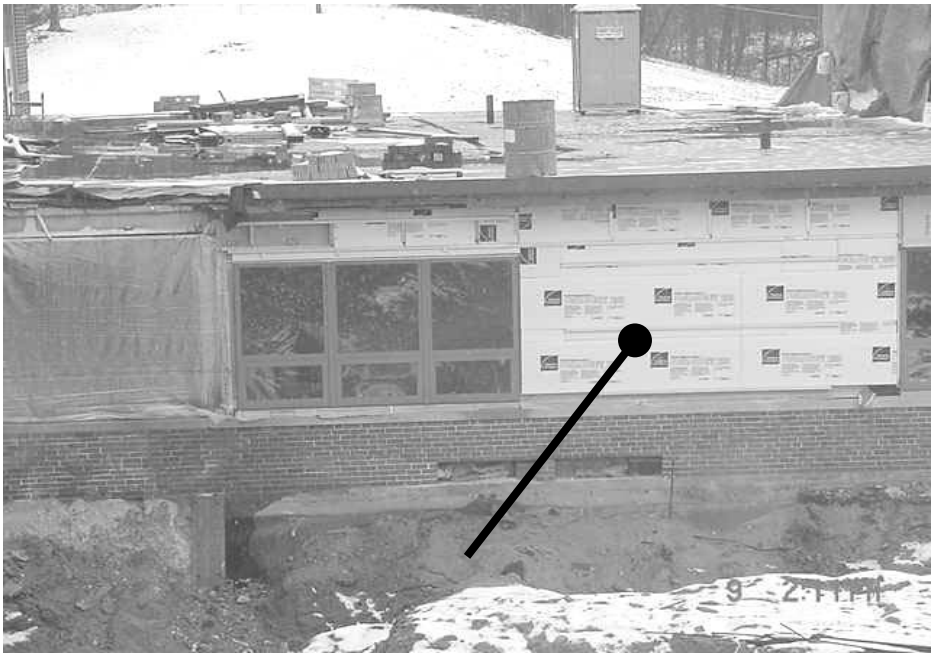
Picture 11

Moisture Sampling of GW

Picture 12

Exterior Curtain Walls of the Unfinished Sections Are Brick

Picture 13



Styrofoam-Like Material Adhered to GW

Picture 14

Interior Surface of GW Adhered to GW Styrofoam-Like Material

Picture 15

Water Damage/Viable Mold Growth on GW

Picture 16

Water Damage/Mold Growth on Wall Plaster, Note Exposed Wire Mesh

Picture 17

Water Damage/Mold Growth on Wall and Standing Water on Floor

Picture 18

Standing Water and Black Mold Growth along Base of Wall

Picture 19

Stack of Stored GW in Unfinished Wing

Picture 20

Ductwork to Be Installed Stored Outdoors On Slab, Note Water Damage to Box

Picture 21

Ductwork to Be Installed Was Found Stored On the Floors of the Gymnasium

Picture 22

Ductwork Stored On the Floor of the Auditoium

Table 1
Franklin, Horace Mann School - April 9, 2003
Moisture Content Sampling Results

Area	Temperature (^{o} F)	Relative Humidity (%)	Moisture Concentration (%) of GW	Comments
Background	35	86	5.4	Moderate to heavy rainfall, cold & windy
Room 194	36	82	0.5-6.9	Water damage, musty odors, corrosion/rust on door frame base, pooling water on floor
Room 195	38	83	6.5	GW saturated
Room 196	36	83	6.2-7.1	GW saturated, water damage, musty odors
Room 197	37	85	0.9	
Room 198	38	86	1.5-1.6	
Room 189	38	86	1.6	
Room 190	39	86	3.7	
Room 1103	39	84	0.6-0.9	
Room 1104	39	83	0.5	
Room 1105	39	77	0.5	Open seam between GW sheets
Hallway			0.5-0.6	
Room 1117	38	76	0.6	
Room 1119	38	75	0.9	
Room 1142				Standing water, wet cinder block

Table 2
Franklin, Horace Mann School - April 9, 2003
Moisture Content Sampling Results

Music room	39	80		Saturated wall plaster
Auditorium	51	75	0.1-0.2	GW dry, pooling water under stage, seepage from handicapped ramp area
Auditorium Hallway	56	71	0.6	
Room 160	46	55	0.6-0.7	
Room 157	46	56	0.6	
Room 156	46	56	0.6	
Room 180	46	57	0.5	
Room 181	46	58	0.7	
Room 1100	45	62		Saturated wall plaster along base of wall 13.4 %
Room 011	38	83	1.4	Visible mold growth
Room 145	53	89	0.9	
Room 144	54	78	1.8	Visible mold growth
Room 121	50	72	0.2	
Stairwell #2				Damaged window caulking (rubber strip)
Library	58	76	0.2-0.5	Reported window leakage
Area C	45	82		GW saturated, buckled, 4-5” of standing water near handicapped ramp, leaking into auditorium under stage